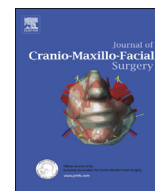


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# Analysis of MRI findings in minimum invasive treatment for habitual temporomandibular joint dislocation by autologous blood injection around the temporomandibular joint capsule



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## ABSTRACT

The aim of this study was to investigate magnetic resonance imaging (MRI) findings following autologous blood injection (ABI) for habitual temporomandibular joint (TMJ) dislocation. MRI was performed one hour and four and twelve weeks after ABI, revealing three types of significant findings. The first type was similar to hematoma and/or joint effusion in the articular capsule of the TMJ (type I). The second showed sporadic and diffuse T2 emphasis around the TMJ capsule (type II). The third involved a decreased range of condyle movement compared to before ABI (type III). Furthermore, we analyzed the three types of significant MRI findings.

At one hour after ABI, type I was Grade 0 in 0 of 14 patients, Grade 1 in 8, Grade 2 in 2, and Grade 3 in 4. Type II was seen in 9 of the 14 cases and type III in 8. After twelve weeks, all cases of type I were Grade 0, no type II cases were evident, and type III was seen in 11 cases. Injecting autologous blood into surrounding TMJ tissues is an important factor in ABI. Minimally invasive treatment for habitual TMJ dislocation using ABI around the TMJ capsule appears to represent a very effective and safe treatment.

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## 1. Introduction

Dislocation of the temporomandibular joint (TMJ) is considered to involve a combination of three factors: stretching of the masticatory muscles and capsular ligaments; a large articular tubercle; and muscle spasm. Stretching of the mandibular and TMJ capsule ligaments permits the mandibular condyle to move further anteriorly during mandibular opening, passing over the articular tubercle. With some patients, as the extended articular tubercle functions as a mechanical barrier, reduction of the condyle does not occur. Once the condyle passes over the articular tubercle, muscle spasm between the protractor muscles will continue to push the condyle forward while the elevator muscles try to push the mandible back, keeping the condyle anterior to the articular tubercle. Return of the condyle head to the mandibular fossa thus becomes difficult (Hasson and Nahlieli, 2001).

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Various conservative methods can be used to treat habitual dislocation of the TMJ. Non-surgical methods are usually applied before any decision to perform surgery (LeClerc and Giral, 1943; MacFarlane, 1977; McKelvey, 1950; Myrhaug, 1951; Schultz, 1937; Segami et al., 1999). Various non-surgical treatment models have been described in the past, including injection of a sclerosing solution into the superior articular cavity (tincture of iodine, alcohol, and picibanil) (Becker, 1954). However, that approach has not been used in many cases due to the risk of adverse reactions such as facial paralysis and traumatic arthritis (Kato et al., 2007; Machon et al., 2009). Another procedure with less adverse reactions is the use of botulinum toxin (Bakke et al., 2005), which is injected into the lateral pterygoid muscle to block movement of the mandible. In this way, displacement of the mandibular condyle is prevented even when the mouth is opened excessively (Fu et al., 2010; Vázquez Bouso et al., 2010).

Autologous blood injection (ABI) around the TMJ as a treatment for habitual TMJ dislocation was first reported by Brachmann (1964). Several articles followed (Jacobi and Tetsch, 1981; Schulz, 1973), but the technique never gained widespread popularity. ABI has recently been reintroduced as a treatment for habitual TMJ

dislocation, with Hegab (2013) and Yoshida et al. (2013) reporting good effects against dislocation.

ABI is a simple technique that can be performed on an outpatient basis, and offers a very safe, simple and effective treatment for patients categorized as high risk for surgical treatment. Once injected into the superior compartment of the TMJ and into the pericapsular tissue, autologous blood is considered to cause scarring and fibrosis (Schultz, 1937). The resulting fibrous tissue causes a reduction in mandibular movements, stopping habitual TMJ dislocation of the condyle.

Gulsen et al. (2013) also reported that histological findings showed that ABI could result in fibrotic changes in the capsule and retrodiscal ligament of the TMJ in a pig model. Furthermore, Yoshida et al. (2013) reported that good results were obtained when 20 patients underwent ABI into the superior compartment and periarticular capsule. We consider that applying ABI around the TMJ capsule is the most important factor for success.

Despite the recent reintroduction of ABI (Hegab, 2013; Yoshida et al., 2013; Güven, 2009), reports regarding magnetic resonance imaging (MRI) findings following ABI are scarce (McKelvey, 1950; Myrhaug, 1951). The aim of this study was thus to investigate MRI findings following ABI treatment of habitual TMJ dislocation in terms of significant differences within and/or around tissues of the TMJ capsule.

## 2. Materials and methods

Fourteen consecutive patients (4 males, 10 females) who presented to the First Department of Oral and Maxillofacial Surgery at Osaka Dental University and were diagnosed with habitual TMJ dislocation were included in this prospective study. Mean age at the time of presentation was 57.0 years (range, 17–82 years). Six cases involved left-side TMJ dislocation, and 8 cases were right-sided. Mean duration of symptoms was 32.6 months (range, 2 months – 15 years). Seven patients had concomitant systemic disease (Table 1).

Patients were diagnosed with TMJ dislocation based on the following clinical and radiographic criteria (Nitzan, 2002):

- 1) maximal mouth opening during the event greater than maximal opening;

- 2) computed tomography showing condyle location in front of and superior to the articular tubercle; and
- 3) MRI showing the condyle located in front of the articular tubercle during the open-mouth position.

Instead of open surgical intervention, all patients underwent ABI to the TMJ. All procedures were performed by the same surgeon, in the same hospital, and following the same protocol. We examined the number of dislocation episodes and duration of symptoms in a medical interview.

ABI was applied to the patient under local anesthesia. After preparing the patient in the usual manner, the surgeon visually identified a line from the tragus to the lateral angle of the eye. The articular fossa (AF) is found using this line, 10 mm anterior to the tragus of the ear and 2 mm inferior to the line. Local anesthesia of the auricular temporal nerve was applied to the patient, and a 22-gauge needle was inserted into the AF at the identified point. After 3 ml of 1% lidocaine was injected, the 22-gauge needle was left for pumping in the AF point. Referring to the 2001 report by Hasson and Nahlieli, 5 ml of blood was drawn from the patient's antecubital fossa, and the syringe was connected to the previously inserted needle. Approximately 3 ml of blood was injected into the superior compartment and approximately 2 ml into the pericapsular tissue (anterior, posterior, and outside).

Antibiotic medication was initiated from 3 days before the procedure for all patients. After the procedure, patients received non-steroidal anti-inflammatory drugs for analgesia. The patients were provided with specific instructions to guide postoperative rehabilitation and establish controlled mouth opening. After the first month, all patients had restricted mouth opening of 25 mm and followed a diet limited to soft foods only. We did not perform intermaxillary wire fixation or use any other specific appliances to prevent TMJ dislocation. After 1 year, none of the 14 patients (0%) had shown any recurrent dislocations of the TMJ. MRI was performed for each of the 14 patients at one hour, four weeks, and twelve weeks after ABI.

MRI examination was performed using a Signa 1.5-T system (GE Healthcare, Milwaukee, WI). When MRI examinations of the opening position of the TMJ were carried out, we used a silicone block (thickness, 10 mm) to keep the mouth open.

**Table 1**  
Clinical information of examination cases and MRI findings of ABI.

No	Age	Sex	Side	Onset	Systematic disease	Preope	One hour			Four weeks			Twelve weeks		
							I	II	III	I	II	III	I	II	III
1	17 y	F	L	2 y		0	1	+	+	0	–	+	0	–	+
2	28 y	F	R	4 m		0	2	+	+	0	–	+	0	–	+
3	29 y	M	R	5 y		0	3	+	+	0	–	+	0	–	+
4	32 y	F	R	1 y		0	3	+	+	0	–	+	0	–	+
5	32 y	F	L	1 y		0	1	+	+	0	–	+	0	–	+
6	44 y	F	L	15 y	Hashimoto's disease, Schizophrenia	0	2	–	–	0	–	–	0	–	–
7	63 y	M	R	1 y		0	3	+	–	0	–	–	0	–	+
8	73 y	M	R	3 m	Hydrocephalus	0	1	+	–	0	–	+	0	–	+
9	73 y	M	L	3 m	Hydrocephalus	0	3	+	–	0	–	+	0	–	+
10	77 y	F	R	2 m	Dementia, Diabetes	0	1	–	+	0	–	–	0	–	+
11	78 y	F	L	6 m	Angina pectoris	0	1	+	+	0	–	+	0	–	+
12	80 y	F	L	1 y	Cerebral infraction, Diabetes	0	1	–	–	0	–	+	0	–	–
13	81 y	F	R	6 m	Cerebral infraction	0	1	–	+	0	–	–	0	–	+
14	82 y	F	R	10 y	Cerebral infraction, Parkinson's disease	0	1	–	–	0	–	–	0	–	–

m : months, y : years, M : male, F : female, R : right, L : left.

Male : 4 cases, Female : 10 cases.

Right side : 8 cases, Left side : 6 cases.

Type I : Kaneyama et al.'s classification Grade 0–3.

Type II : (+) : appearance of image of sporadic and diffused T2 emphasized around the TMJ capsule, (–) : not emphasized.

Type III : (+) : case of decrease in the movable region of the condyle, (–) : no changings.

We analyzed three types of significant MRI findings from ABI. The first was similar to hematoma and/or joint effusion in the articular capsule of TMJ (type I) [Fig. 1](#). The second type showed sporadic and diffuse T2 emphasis around the TMJ capsule (type II) [Fig. 2](#). The third type involved a decrease in the range of mandibular condyle movement compared to before ABI (type III) [Fig. 3](#).

We evaluated MRI findings with joint effusion of the capsule based on the classification by [Kaneyama et al. \(2010\)](#), as Grade 0–3. In MRI findings of type II, if we could find images of sporadic and diffuse T2 emphasis around the TMJ capsule, the case was regarded as positive. When no such emphasis was apparent, the case was considered negative. In comparing MRI findings between before and after ABI for type III, cases with a decreased range of condyle movement were considered positive, and all others were considered negative.

Control data were obtained by patients (2 men, 12 women) with a mean age of 55.5 years (range, 24–76 years) who underwent pumping treatment for temporomandibular disorder ([Murakami et al., 1987](#)). The side contralateral to the side of pumping treatment was investigated for MRI findings (types I, II and III) before treatment and after four weeks ([Table 2](#)).

All study protocols were approved by the Osaka Dental University Medical Ethics Committee (No. 080134).

### 3. Results

#### 3.1. MRI findings one hour after ABI

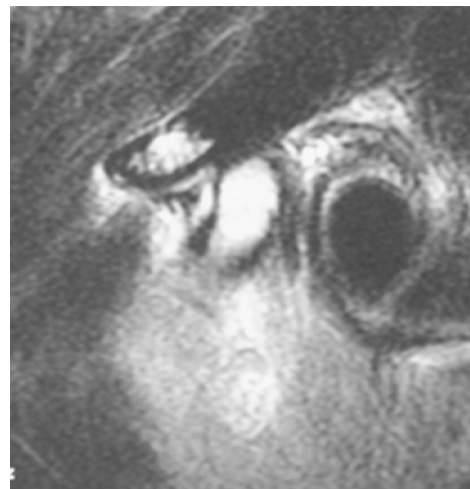
MRI findings for type I were found in all 14 cases: Grade 0, 0/14 (0%); Grade 1, 8/14 (57.1%); Grade 2, 2/14 (14.3%); and Grade 3, 4/14 (28.6%). For type II, 9 patients (64.3%) were positive and 5 (35.7%) were negative. For type III, 8 patients were positive (57.1%) and 6 (42.9%) were negative ([Table 1](#)).

#### 3.2. MRI findings four weeks after ABI

Four weeks after ABI, 9 patients were examined with MRI. All type I findings at this time were Grade 0 (100%). For type II, no positive cases were found, and all 9 patients (100%) were negative. For type III, 8 patients (88.9%) were positive and 1 (11.1%) was negative ([Table 1](#)).



**Fig. 1.** The MR imaging of type I expression. T2 weighted image pressing high signal intensity in the upper articular space.



**Fig. 2.** The MR imaging of type II expression. Sporadic and diffused T2 weighted image in the TMJ capsule.

#### 3.3. MRI findings twelve weeks after ABI

Twelve weeks after ABI, all 14 patients underwent MRI. All type I findings were again Grade 0 (100%). For type II, no positive cases were found, and all 14 patients (100%) were negative. For type III, 11 patients (78.6%) were positive and 3 (21.4%) were negative ([Table 1](#)).

#### 3.4. MRI findings in control cases

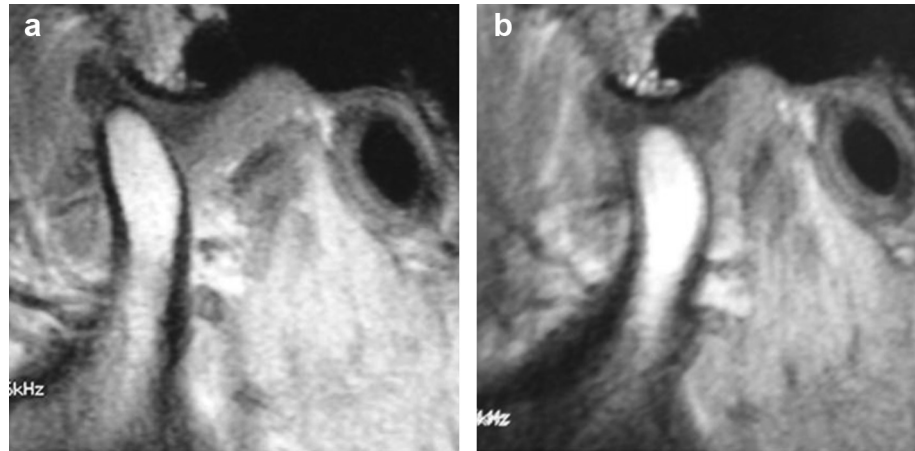
For type I findings, 4 patients (28.6%) were grade 1 and 10 (71.4%) were grade 0 before pumping treatment of the TMJ. At four weeks after treatment, 3 patients (21.4%) were grade 1 and 11 (78.6%) were grade 0. For Type II, all patients (14/14, 100%) were negative both before and after treatment. Similarly, all 14 patients (100%) showed negative results for type III ([Table 2](#)).

### 4. Discussion

Our previous study described the minimally invasive nature and positive effects on habitual TMJ dislocation of ABI around the TMJ capsule ([Yoshida et al., 2013](#)). [Daif \(2010\)](#) recently reported ABI to the TMJ in patients with habitual dislocation as a simple, safe, and cost-effective technique. In that study, 30 patients with chronic recurrent TMJ dislocation were randomly divided into two equal groups: Group A, treated using only 2 ml of ABI into the superior articular cavity; and Group B, which received 2 ml of ABI to the superior articular cavity and 1 ml in the pericapsular tissues. At the end of the 1-year follow-up period, the results of that study showed that ABI to the superior articular cavity and pericapsular tissues yielded a higher success rate (80%) than injection into the superior articular cavity alone (60%). Moreover, the decrease in maximal mouth opening was larger for Group B than for Group A. MRI findings for the joints in Group B only showed the condylar head posterior to the articular eminence in open position, instead of being anterior before the injection. In both groups, no destructive changes to bony components of the joint have been observed.

In those studies ([Yoshida et al., 2013](#); [Daif, 2010](#)), minimally invasive treatment for habitual TMJ dislocation using ABI around the TMJ capsule was reported as a very safe, simple, and effective treatment for all patients.

In the present study, 8 of 14 patients had systemic disease ([Table 1](#)). None of the 14 patients experienced any recurrence or



**Fig. 3.** The MR imaging of type III expression. a: Open position of the preoperation. b: Open position of the postoperation. When compared with a and b, it was detected that decreasing in the movable range of the mandibular condyle.

**Table 2**

MRI findings of control cases.

No	Age	Sex	Affected side	Preoperation <sup>a</sup>	Postoperation <sup>a</sup>
1	24 y	F	R	0	0
2	27 y	F	L	0	0
3	33 y	F	L	1	0
4	50 y	F	L	0	0
5	53 y	F	L	2	2
6	56 y	F	R	0	0
7	56 y	M	L	0	0
8	60 y	F	R	0	0
9	61 y	F	L	1	1
10	64 y	F	L	1	1
11	70 y	M	R	0	0
12	73 y	F	R	0	0
13	74 y	F	R	1	1
14	76 y	F	L	0	0

y: years, M: male, F: female, R: right, L: left.

Male: 2 cases, Female: 12 cases.

Right side: 6 cases, Left side: 8 cases.

<sup>a</sup> Type I MRI expressions based on Kaneyama's classification.

severe complications in the year following ABI. However, we were unable to examine in detail the relationship between systematic disease and specific MRI findings. In the future, we intend to investigate the prognosis and accumulate many more cases of minimally invasive treatment for habitual TMJ dislocation using ABI around the TMJ capsule in patients at high risk from surgical treatment.

In another report, [Hasson and Nahlieli \(2001\)](#) mentioned that restraining mandibular movement is the key to the success of the procedure. The pain that follows the injections will also restrain mandibular movement, permitting the injected blood to settle and create fibrosis. The present study did not perform intraoral maxillary wire fixation following ABI.

[Candirli et al. \(2012\)](#) investigated the effects of ABI for chronic recurrent TMJ dislocation using MRI. In that report, 1 month after injection, TMJ dislocations were not observed in the MRI evaluations of any patient. No significant structural change caused by ABI was observed.

In our study, accumulation similar to joint effusion in the superior TMJ capsule (Kaneyama's classification Grade 1–3) was observed from one hour after ABI (14/14: 100%).

Nine of the 14 cases revealed findings similar to sporadic and diffuse T2 emphasis in tissues around the TMJ (9/14: 64.3%). The reason such findings were not evident in the 5 cases was attributed

to autologous blood distributing between connective tissues. Accumulation of injected autologous blood is not always revealed on MRI, because the blood easily diffuses between sparse connective tissues.

Type I and II findings were only evident at one hour after ABI. After four and twelve weeks, neither finding was identified. The injected autologous blood was thus considered to have been completely absorbed.

Restricted movement of the condylar head was found in 8 cases (57.1%) at one hour after ABI. After twelve weeks, this number increased to 11 (78.6%). When performing MRI, we applied silicone bite blocks (thickness, 10 mm). This does not represent the maximum opening position of the TMJ. However, type III findings were still expressed. These results suggest that ABI restricts anterior protrusion of the condylar head. From one hour to twelve weeks after ABI, the number of cases showing restricted condylar movement increased. We considered that this increase in type III-positive results was related to the appearance of sporadic and diffuse T2 emphasis around TMJ tissues (type II-positive results).

This result adds weight to our hypothesis that the presence of autologous blood around the TMJ capsule is the most important factor for successful treatment using ABI. In the near future, ABI around the TMJ capsule might become established as an independent treatment for habitual TMJ dislocation. However, this study only investigated a small number of samples. More detailed clinical and histopathological studies are therefore warranted.

## 5. Conclusion

This study found three important types of MRI finding after ABI. Our results suggest that injecting autologous blood into tissues surrounding the TMJ is a very important factor in the success of ABI. Minimally invasive treatment for habitual TMJ dislocation using ABI around the TMJ capsule appears to represent a very effective and safe treatment.

## Conflict of interest statement

The authors have no conflicts of interest to declare.

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